

## PATENT ABSTRACTS OF JAPAN

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(71)Applicant : HONDA MOTOR CO LTD

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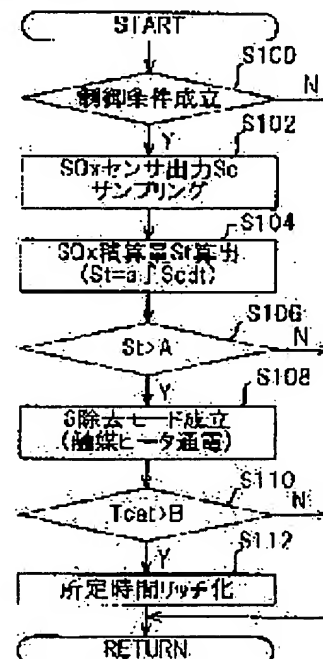
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## (54) EXHAUST EMISSION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To judge the deterioration of a NOx absorbing catalyst (NOx absorbent) caused by the sulfur poisoning, with high accuracy and eliminate the attached sulfur to regenerate the catalyst.

SOLUTION: A SOx sensor is arranged in an exhaust system to detect the concentration of sulfur in the exhaust gas (S102), and a SOx integrated amount is calculated on the basis of the detected value (S104). When the integrated amount is over a predetermined value A, the power is supplied for the heating (S106, S108), and an air/fuel ratio is enriched (S112) when the exhaust temperature Tcat is over a predetermined temperature B (S110).



## LEGAL STATUS

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CLAIMS

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[Claim(s)]

[Claim 1] The NOx absorbent which absorbs NOx in exhaust gas when it is prepared in an internal combustion engine's exhaust air system and exhaust gas is in lean atmosphere, A heating means to heat said NOx absorbent, and a sulfur concentration detection means for it to be prepared in the upstream of the arrangement location of said NOx absorbent, and to detect the sulfur concentration in exhaust gas, A degradation judging means to judge degradation by sulfur poisoning of said NOx absorbent based on the output of said sulfur concentration detection means, When the temperature which said degradation was judged by temperature presumption means to presume the temperature of said NOx absorbent, and said degradation judging means, and was presumed by said temperature presumption means is higher than sulfur poisoning regenerating temperature, The exhaust emission control device of the internal combustion engine characterized by having the sulfur clearance control means which supplies theoretical air fuel ratio or the rich air-fuel ratio not more than it.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to what removes poisoning easily and reproduced the NOx absorbent (NOx absorption catalyst) to poisoning, such as sulfur, in more detail about an internal combustion engine's exhaust emission control device.

[0002]

[Description of the Prior Art] As an internal combustion engine's exhaust gas clarification catalyst, an oxidation catalyst, the three way component catalyst, the NOx selection reduction catalyst, the NOx absorption catalyst (NOx absorbent), HC absorption catalyst, etc. are proposed variously. In recent years, Lean-ization of air-fuel ratios, such as a lean burn engine, is progressing, and if such an engine has, clarification of the NOx (nitrogen oxides) component in lean atmosphere is in drawing using a NOx absorption catalyst (NOx absorbent) etc.

[0003] By the way, although Sulfur S is contained in the fuel, if the sulfur adheres to a catalyst front face or micropore as SOx (sulfur oxide) (absorption), the clarification effectiveness of a catalyst will be reduced. If it is in the catalyst which carries out reduction clarification of the NOx which absorbed NOx with the NOx absorption catalyst especially described above (NOx absorbent), i.e., lean atmosphere, and was absorbed in response to the supply which is not burned [ HC ] (reducing agent), sulfur is easy to be absorbed, the so-called sulfur poisoning is produced, and NOx absorption efficiency is reduced.

[0004] Then, JP,6-66129,A made the air-fuel ratio of the gaseous mixture to supply theoretical air fuel ratio, and has proposed the technique which removes SOx and reproduces a catalyst while it carries out fixed time amount energization heating of the electric heater, when the amount of sulfur poisoning is presumed from car mileage, a NOx absorbed amount, or an exhaust-gas temperature and estimate exceeds a predetermined value.

[0005] Moreover, the air-fuel ratio of the gaseous mixture to supply was made rich, and JP,7-217474,A has also proposed the technique which removes SOx and reproduces a catalyst, when exhaust gas temperature exceeds a predetermined value, while the amount of sulfur poisoning is presumed from an engine rotational frequency etc. and estimate exceeds an allowed value.

[0006]

[Problem(s) to be Solved by the Invention] By the way, in the U.S., although the sulfur in the fuel sold in Japan is regulated by 30 ppm, although there are many 1000 ppm and sulfur contents by the average at 400 ppm and a regulation value and it changes with countries even in Europe, a country hundreds of ppm or more is the majority.

[0007] Although the catalyst (NOx absorbent) needed to be exactly reproduced in quest of sulfur poisoning with a sufficient precision since sulfur poisoning also increased as the sulfur content in a fuel increased, it was not what presumes the amount of sulfur poisoning from car mileage etc. in the above-mentioned conventional technique, detects the sulfur concentration in exhaust gas, presumes the amount of sulfur poisoning based on it, and performs catalyst regeneration.

[0008] Therefore, it is in the object of this invention offering the exhaust emission control device of the internal combustion engine which is to cancel the above-mentioned inconvenience, detects the sulfur concentration in exhaust gas, judges degradation of the NOx absorbent by sulfur poisoning more directly based on it, and was made to regenerate exactly.

[0009]

[Means for Solving the Problem] If it is in claim 1 term in order to attain the above-mentioned object The NOx absorbent which absorbs NOx in exhaust gas when it is prepared in an internal combustion engine's

exhaust air system and exhaust gas is in lean atmosphere, A heating means to heat said NOx absorbent, and a sulfur concentration detection means for it to be prepared in the upstream of the arrangement location of said NOx absorbent, and to detect the sulfur concentration in exhaust gas, A degradation judging means to judge degradation by sulfur poisoning of said NOx absorbent based on the output of said sulfur concentration detection means, When the temperature which said degradation was judged by temperature presumption means to presume the temperature of said NOx absorbent, and said degradation judging means, and was presumed by said temperature presumption means is higher than sulfur poisoning regenerating temperature, It constituted so that it might have the sulfur clearance control means which supplies theoretical air fuel ratio or the rich air-fuel ratio not more than it.

[0010] By this, the sulfur concentration in exhaust gas can be detected and degradation judging precision can be raised by judging degradation by sulfur poisoning more directly based on it. Therefore, also when using a fuel with many sulfur contents, a NOx absorbent can be regenerated exactly.

[0011]

[Embodiment of the Invention] The gestalt of operation of the exhaust emission control device of the internal combustion engine which is based on an accompanying drawing and is hereafter applied to this invention is explained.

[0012] Drawing 1 is the general drawing showing the exhaust emission control device roughly.

[0013] in drawing, a sign 10 should show the body of the Taki cylinder internal combustion engines (henceforth an "engine"), such as a 4-cylinder, and the inhalation of air introduced from the air cleaner (not shown) arranged at the head of an inlet pipe 12 should pass a surge tank and an inlet manifold (not shown [ both ]), having the flow rate adjusted by the throttle valve 14 -- it flows into each cylinder.

[0014] An injector (fuel injection valve) 16 is formed near the intake valve (not shown) of each cylinder, and a fuel is injected. The gaseous mixture which was injected and was united with inhalation of air is lit with the ignition plug which is not illustrated within each cylinder, burns, and drives a piston (not shown).

[0015] The exhaust gas after combustion is sent to an exhaust pipe 18 through an exhaust air bulb (not shown) and an exhaust manifold (not shown). While a three way component catalyst 22 is arranged in an exhaust pipe 18 at the upstream and purifying HC in exhaust gas, CO, a NOx component, etc., the NOx absorption catalyst (the above mentioned NOx absorbent) 24 is arranged on the lower stream of a river.

[0016] if the oxygen density in exhaust gas falls while the NOx absorption catalysts 24 are the NOx absorbent indicated by JP,6-66129,A or JP,7-217474,A described previously and a catalyst of the same kind and absorbing NOx in exhaust gas by lean atmosphere (oxidizing atmosphere) -- namely, a rich ambient atmosphere -- setting -- unburnt -- it reacts with HC and CO and reduction clarification of the NOx is carried out.

[0017] Here, after the support which supports the NOx absorption catalyst 24 carries out extrusion molding of the raw material, it is calcinated and ceramic-ized, and is judged and manufactured by die length proper subsequently. A current path is formed in support and it is constituted as a catalyst of the electric heating type which NOx absorption catalyst 24 the very thing equips with electrical heater structure. A current path is connected to the forward negative-electrode terminals 24a and 24b.

[0018] If the equipment of drawing 1 is equipped with a change-over switch 26 and terminal 26a of a change-over switch 26 is switched to 26b, it will connect with AC dynamo 28 and positive-electrode terminal 24a will raise the temperature of the NOx absorption catalyst 24 in response to supply of a current from AC dynamo 28.

[0019] In addition, if terminal 26a of a change-over switch 26 is switched to terminal 26c, it will connect with the positive electrode of a dc-battery 30, and the output of AC dynamo 28 will charge a dc-battery 30. The positive electrode of a dc-battery 30 is connected to the electric load containing the motor (not shown) of the air pump 34 described above through the line 32.

[0020] It connects with the other end of the fork road 36 which branched in the upstream of the NOx absorption catalyst 24 arrangement location of an exhaust pipe 18, and an air pump 34 supplies oxygen, promotes combustion of a non-burned component, and raises clarification effectiveness.

[0021] While the crank angle sensor 38 is formed near the cam shaft of an engine 10, or a crankshaft (not shown [ both ]) in drawing 1 and outputting Signal CRK for whenever [ predetermined crank angle / every ], a cylinder distinction signal is outputted by whenever [ specific crank angle / of a specific cylinder ].

[0022] The signal which the throttle opening sensor 40 was formed in the throttle valve 14, and is proportional to throttle opening  $\theta_{TH}$  is outputted. The absolute-pressure sensor 44 is formed in the end of the fork road 42 of the lower stream of a river, and the signal according to the absolute pressure PBA in an inlet pipe is outputted to it.

[0023] Furthermore, while outputting the signal which an intake temperature sensor 46 is formed in the lower stream of a river of a branch location, and is proportional to the inhalation air temperature TA, suitably, a coolant temperature sensor 48 is formed in a location, and the signal according to engine-cooling-water \*\* TW of a cylinder block etc. is outputted to it.

[0024] Furthermore, in an exhaust pipe 18, it is O<sub>2</sub>. A sensor 50 is formed and the signal proportional to the oxygen density in exhaust gas is outputted.

[0025] Furthermore, between a three way component catalyst 22 and the NO<sub>x</sub> absorption catalyst 24, the exhaust-gas-temperature sensor 52 is formed and the signal according to exhaust gas temperature T<sub>cat</sub> near the arrangement location of the NO<sub>x</sub> absorption catalyst 24 is outputted.

[0026] Furthermore, the SO<sub>x</sub> sensor (the above mentioned sulfur concentration detection means) 54 is formed in the lower stream of a river of the NO<sub>x</sub> absorption catalyst 24, and the signal proportional to the concentration S<sub>c</sub> of the sulfur in exhaust gas is outputted.

[0027] Drawing 2 is the explanation sectional view showing the configuration of the SO<sub>x</sub> sensor 54 in a detail.

[0028] the criteria room which is open for free passage to atmospheric air while the SO<sub>x</sub> sensor 54 presents the plate which comes to carry out the laminating of the solid electrolyte layers of oxygen ion conductivity, such as zirconia ceramics, and the 1st test-chamber (building envelope) 54a, the 2nd test-chamber (building envelope) 54b, and 3rd test-chamber (building envelope) 54c are formed -- 54d is formed.

[0029] Exhaust gas flows to 1st test-chamber 54a through 54m of gaseous diffusion rate-limiting layers. A pump cel is constituted from electrodes 54e and 54f by the 1st test-chamber 54a, the oxygen of the measurement interior of a room is pumped out, and oxygen tension is controlled to the value which must have been returned to NO<sub>x</sub>. The oxygen density in exhaust gas is detected by detecting the oxygen tension as the Electrodes [ 54g and 54h ] potential difference.

[0030] Similarly the electrodes 54i and 54j which consist of NO<sub>x</sub> reduction catalysts, such as Rh, are formed in the 2nd test-chamber 54b, the oxygen tension generated by reduction or decomposition of oxygen tension, i.e., NO<sub>x</sub>, by detecting the potential difference is detected, and NO<sub>x</sub> concentration is detected.

[0031] Similarly the electrodes 54k and 54l. which consist of SO<sub>x</sub> reduction catalysts, such as Pt, are formed in the 3rd test-chamber 54c, and SO<sub>x</sub> concentration is detected from those potential difference. Thus, the SO<sub>x</sub> sensor 54 can detect not only SO<sub>x</sub> concentration but an oxygen density and NO<sub>x</sub> concentration collectively.

[0032] The output of these sensors group is sent to an electronic control unit (henceforth "ECU") 60.

[0033] ECU60 consists of input circuit 60a, CPU60b, storage means 60c, and 60d of output circuits. Input circuit 60a processes changing into predetermined level the signal level which operates the input signal wave from various sensors orthopedically, changing an analog signal value into a digital signal value, etc. Storage means 60c memorizes various operation programs, the result of an operation, etc. which CPU60b performs.

[0034] CPU60b counts the above mentioned CRK signal, calculates fuel oil consumption (injector valve-opening time amount) from the engine speed NE which detected and detected the engine speed NE, and the absolute pressure PBA in an inlet pipe, and amends it with a target air-fuel ratio etc.

[0035] A target air-fuel ratio is set as the values (for example, 30:1 etc.) of the direction of Lean which exceeds theoretical air fuel ratio at the time of low load driving by the value (for example, 12:1) of the rich direction of under theoretical air fuel ratio at the time of heavy load operation.

[0036] Furthermore, CPU60b judges degradation by sulfur poisoning of the NO<sub>x</sub> absorption catalyst 24, and performs the clearance (playback). That is, from reducing NO<sub>x</sub> absorption efficiency, if the so-called sulfur poisoning to which the sulfur component in exhaust gas adheres to a catalyst front face or micropore as SO<sub>x</sub> (sulfur oxide), and the clarification effectiveness of a catalyst is reduced becomes excessive, absorbed SO<sub>x</sub> is removed and the NO<sub>x</sub> absorption catalyst 24 is reproduced.

[0037] Subsequently, actuation of the exhaust emission control device of the internal combustion engine concerning this invention is explained.

[0038] Drawing 3 is a flow chart which shows the actuation. In addition, the program of a graphic display is performed by every proper time interval (for example, 80msec(s)).

[0039] If it explains below, it will judge whether in S100, a control condition and the conditions which perform sulfur poisoning degradation judging and catalyst regeneration in more detail are satisfied. This condition is judged to be formation when an engine 10 is specifically in a steady operation condition, while the NO<sub>x</sub> absorption catalyst 24 is in 400 degrees C from 300 degrees C and is being activated.

[0040] When denied by S100, while skipping subsequent processings, the output S<sub>c</sub> of the SO<sub>x</sub> sensor 54

which progressed to S102 when affirmed, and was described above (sulfur concentration in exhaust gas) is sampled.

[0041] Subsequently, the amount  $St$  of SOx addition (namely, the amount of sulfur poisoning) presumed to have been absorbed by the NOx absorption catalyst 24 based on the sulfur concentration  $Sc$  which progressed to S104 and was detected, and a multiplier  $a$  (adsorption) is computed.

[0042] The amount  $St$  of SOx addition multiplies by the sulfur concentration which asked for the exhaust gas volume  $Vg$  which flowed the exhaust pipe 18, and detected it to the calculated value, and, more specifically, it asks in integrating over the predetermined time which described the product above.

[0043] This exhaust gas volume  $Vg$  is map-ized free [ retrieval ] from an engine speed  $NE$  and the absolute pressure  $PBA$  in an inlet pipe. In addition, it is the multiplier which shows the rate presumed that the multiplier  $a$  was absorbed by the NOx absorption catalyst 24 in the SOx integrated value supplied to the arrangement location of the NOx absorption catalyst 24 (adsorption).

[0044] Subsequently, it judges whether the amount  $St$  of SOx addition which progressed to S106 and was calculated exceeds the predetermined value  $A$ . Here, the predetermined value  $A$  is a threshold which is sufficient for judging degradation of the NOx absorption catalyst 24, and is set up in quest of a proper value through an experiment.

[0045] While skipping processing after judging with the NOx absorption catalyst 24 having not deteriorated when denied by S106, when affirmed, it judges with the NOx absorption catalyst 24 having deteriorated, and progresses to S108, and close carries out energization heating of the NOx absorption catalyst 24 at a poisoning clearance activity.

[0046] More specifically AC dynamo 28 (or dc-battery 30) is connected to terminal 24a of the heater of the NOx absorption catalyst 24, energization heating is carried out through the above mentioned change-over switch 26, and temperature up of the NOx absorption catalyst 24 is carried out. That is, heating temperature up of the absorbed SOx is carried out from \*\*\*\*ing, if whenever [ catalyst temperature ] reaches before and after 700 degrees C.

[0047] Subsequently, it judges whether the exhaust-gas temperature  $Tcat$  which progressed to S110 and was detected exceeds the predetermined temperature  $B$ . The predetermined temperature  $B$  is set as about 700 degrees C. When denied by S110, while skipping subsequent processings, when affirmed, it progresses to S112 and an air-fuel ratio is made predetermined time (short time) rich.

[0048] consequently, SOx which exhaust gas became a rich ambient atmosphere and was emitted from the NOx absorption catalyst 24 -- unburnt -- it is returned by HC and CO. Thus, the NOx absorption catalyst 24 is reproducible.

[0049] In addition, what is detected is an exhaust-gas temperature near the arrangement location of the NOx absorption catalyst 24, and although it is not the temperature of the NOx absorption catalyst 24 itself, it can be regarded as whenever [ catalyst temperature ] by amending a detection value suitably.

[0050] Since it was made for the gestalt of this operation to regenerate when the sulfur concentration  $Sc$  in exhaust gas was detected like the above, the catalyst de-activation by sulfur poisoning was more directly judged based on it and it was judged with degradation, it can regenerate by the ability judging degradation by sulfur poisoning of a NOx absorption catalyst with a sufficient precision. Therefore, even if the sulfur content of a fuel increases, the NOx absorption catalyst 24 is exactly reproducible.

[0051] Drawing 4 is a flow chart which shows actuation of the exhaust emission control device of the internal combustion engine concerning the gestalt of implementation of the 2nd of this invention.

[0052] If a focus is set and explained to the point which is different from the gestalt of the 1st or the 2nd operation, processings from S200 to S208 will be performed, and it will progress to S210, and will judge whether the resistance welding time  $TON$  to the NOx absorption catalyst 24 exceeded predetermined time  $C$ .

[0053] Predetermined time  $C$  is set up suitably in quest of the value which is sufficient for judging with the temperature of the NOx absorption catalyst 24 having amounted to 700 degrees C.

[0054] When denied by S210, while skipping subsequent processings, when affirmed, it progresses to S212 and an air-fuel ratio is made rich [ short-time ] like the gestalt of the 1st or the 2nd operation.

[0055] Since energization heating is carried out and the temperature up of the NOx absorption catalyst 24 was promoted like the above in the gestalt of the 2nd operation, a poisoning clearance activity can be exactly done like the gestalt of the 1st operation.

[0056] Moreover, since the exhaust-gas temperature (if it puts in another way whenever [ catalyst temperature ])  $Tcat$  was presumed from the resistance welding time  $TON$ , installation of the exhaust-gas-temperature sensor 52 is omissible. In addition, a residual configuration and effectiveness are the same as

the gestalt of the 1st operation.

[0057] Drawing 5 is a flow chart which shows actuation of the exhaust emission control device of the internal combustion engine concerning the gestalt of implementation of the 3rd of this invention.

[0058] If a focus is set and explained to the point which is different from the gestalt of old operation, processings from S300 to S308 will be performed, and it will progress to S310, and will judge whether the energization electric energy E to the NOx absorption catalyst 24 exceeded the predetermined electric energy D.

[0059] The energization electric energy E is computed by installing suitably a voltage sensor and a current sensor (not shown [ both ]), and detecting applied voltage V and force current I. Moreover, the predetermined electric energy D is set up suitably in quest of the value which is sufficient for judging with the temperature of the NOx absorption catalyst 24 having amounted to 700 degrees C.

[0060] When denied by S310, while skipping subsequent processings, when affirmed, it progresses to S312 and an air-fuel ratio is made rich [ short-time ] like the gestalt of the 1st or the 2nd operation.

[0061] Since energization heating is carried out also in the gestalt of the 3rd operation and the temperature up of the NOx absorption catalyst 24 was promoted, a poisoning clearance activity can be exactly done like the gestalt of old operation. In addition, the residual configuration is the same as that of the gestalt of old operation.

[0062] The NOx absorbent which absorbs NOx in exhaust gas when the gestalt of the 1st thru/or operation of the 3rd of this invention is prepared in an internal combustion engine's (engine) exhaust air system (exhaust pipe 18) like the above and exhaust gas is in lean atmosphere (NOx absorption catalyst 24), A heating means to heat said NOx absorbent (NOx absorption catalyst heater), A sulfur concentration detection means for it to be prepared in the upstream of the arrangement location of said NOx absorbent, and to detect the sulfur concentration Sc in exhaust gas (SOx sensor 54), A degradation judging means to judge degradation by sulfur poisoning of said NOx absorbent based on the output of said sulfur concentration detection means (ECU60, S106, S206, S306), A temperature presumption means to presume the temperature Tcat of said NOx absorbent (the exhaust-gas-temperature sensor 52, ECU60, S110, S210, S310), When the temperature which said degradation was judged by said degradation judging means, and was presumed by said temperature presumption means is higher than sulfur poisoning regenerating temperature (700 degrees C), It constituted so that it might have the sulfur clearance control means (from ECU60 and S110 to S112 and S210 to S212 and S310 to S312) which supplies theoretical air fuel ratio or the rich air-fuel ratio not more than it.

[0063] In addition, the SOx sensor 54 may be equipped with the structure indicated by JP,6-174692,A or JP,9-189678,A in the above. Moreover, although the SOx sensor 54 detected the concentration of the sulfur in exhaust gas, it may detect absolute magnitude.

[0064] In addition, in the above, although the catalyst 22 of the upstream was made into the three way component catalyst, you may be a NOx absorption catalyst.

[0065]

[Effect of the Invention] If it is in claim 1 term, the sulfur concentration in exhaust gas can be detected and degradation judging precision can be raised by judging degradation by sulfur poisoning more directly based on it. Therefore, also when using a fuel with many sulfur contents, a NOx absorbent can be regenerated exactly.

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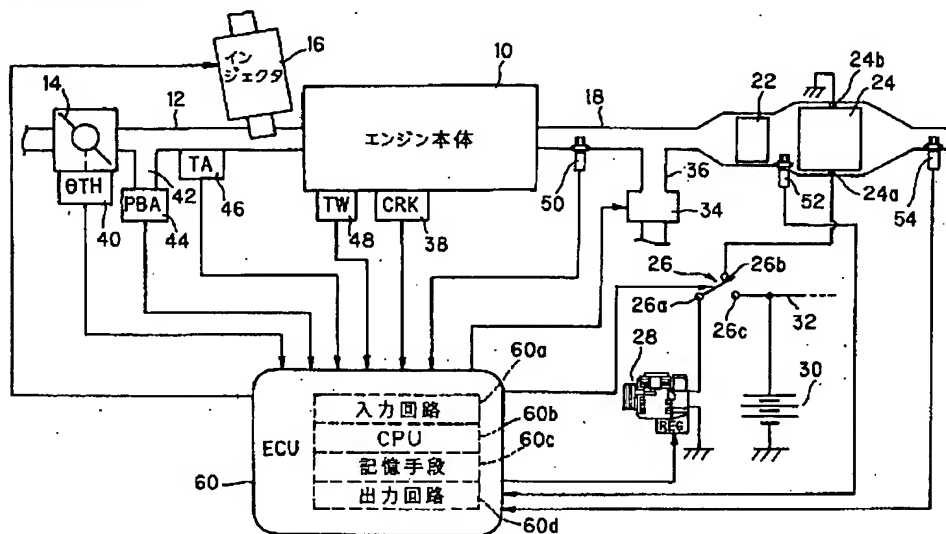
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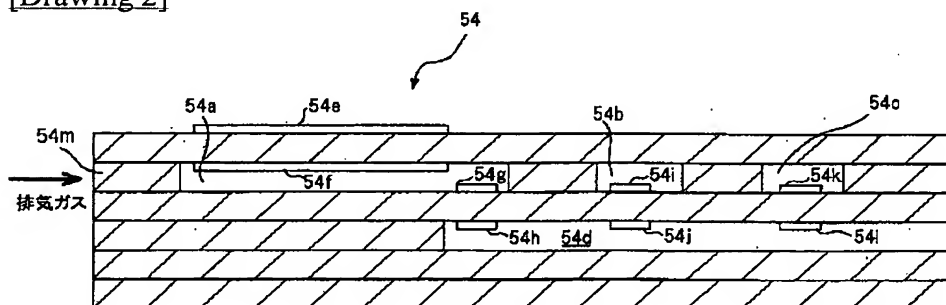
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## DRAWINGS

[Drawing 1]

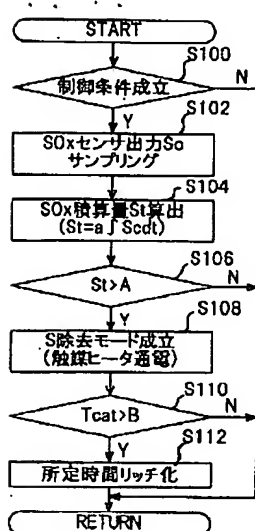


[Drawing 2]

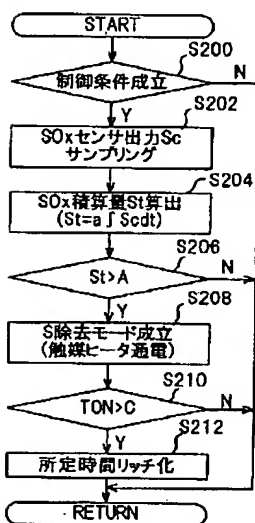


[Drawing 3]

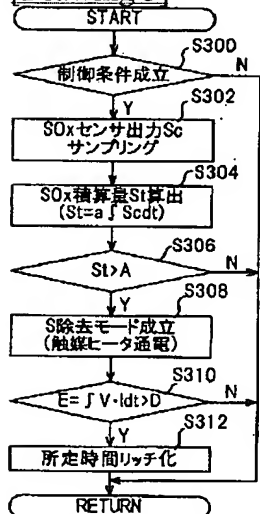




[Drawing 4]



[Drawing 5]



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(19)



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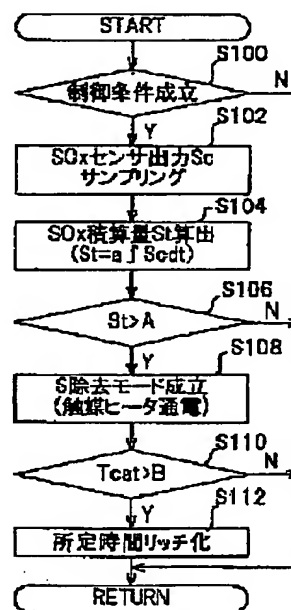
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(57) Abstract

PROBLEM TO BE SOLVED: To judge the deterioration of a NOx absorbing catalyst (NOx absorbent) caused by the sulfur poisoning, with high accuracy and eliminate the attached sulfur to regenerate the catalyst.

SOLUTION: A SOx sensor is arranged in an exhaust system to detect the concentration of sulfur in the exhaust gas (S102), and a SOx integrated amount is calculated on the basis of the detected value (S104). When the integrated amount is over a predetermined value A, the power is supplied for the heating (S106, S108), and an air/fuel ratio is enriched (S112) when the exhaust temperature Tcat is over a predetermined temperature B (S110).

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(71) 出願人 000005326

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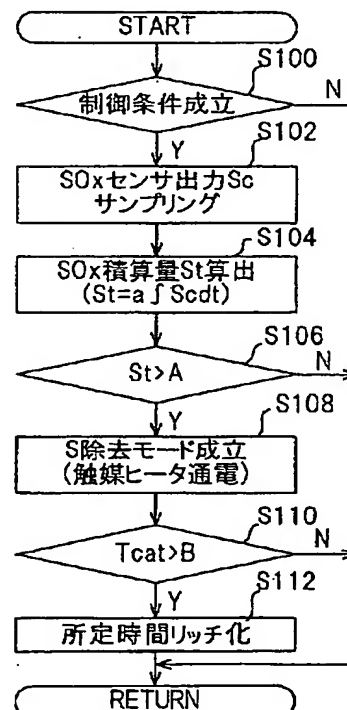
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(54) 【発明の名称】 内燃機関の排気浄化装置

(57) 【要約】

【課題】 NO<sub>x</sub>吸収触媒 (NO<sub>x</sub>吸収剤) の硫黄被毒による劣化を精度良く判定し、付着した硫黄を除去して再生させる

【解決手段】 排気系にSO<sub>x</sub>センサを配置して排気ガス中の硫黄濃度を検出し (S102)、検出値に基づいてSO<sub>x</sub>積算量を算出する (S104)。積算量が所定値Aを超えると通電加熱し (S106, S108)、排気温度T<sub>cat</sub>が所定温度Bを超えると (S110)、空燃比をリッチ化する (S112)。



## 【特許請求の範囲】

【請求項1】 内燃機関の排気系に設けられ、排気ガスがリーン雰囲気にあるとき排気ガス中の $\text{NO}_x$ を吸収する $\text{NO}_x$ 吸収剤と、前記 $\text{NO}_x$ 吸収剤を加熱する加熱手段と、前記 $\text{NO}_x$ 吸収剤の配置位置の上流側に設けられ、排気ガス中の硫黄濃度を検出する硫黄濃度検出手段と、前記硫黄濃度検出手段の出力に基づいて前記 $\text{NO}_x$ 吸収剤の硫黄被毒による劣化を判定する劣化判定手段と、前記 $\text{NO}_x$ 吸収剤の温度を推定する温度推定手段と、前記劣化判定手段により前記劣化が判定され、かつ前記温度推定手段により推定された温度が硫黄被毒再生温度より高いとき、理論空燃比あるいはそれ以下のリッチ空燃比を供給する硫黄除去制御手段とを備えたことを特徴とする内燃機関の排気浄化装置。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】この発明は内燃機関の排気浄化装置に関し、より詳しくは、硫黄などの被毒に対し、容易に被毒を除去して $\text{NO}_x$ 吸収剤（ $\text{NO}_x$ 吸収触媒）を再生するようにしたものに関する。

## 【0002】

【従来の技術】内燃機関の排気ガス浄化触媒としては、酸化触媒、三元触媒、 $\text{NO}_x$ 選択還元触媒、 $\text{NO}_x$ 吸収触媒（ $\text{NO}_x$ 吸収剤）、HC吸収触媒などが種々提案されている。近年、リーンバーン機関など空燃比のリーン化が進みつつあり、そのような機関にあっては $\text{NO}_x$ 吸収触媒（ $\text{NO}_x$ 吸収剤）などを用いてリーン雰囲気での $\text{NO}_x$ （窒素酸化物）成分の浄化を図っている。

【0003】ところで、燃料には硫黄Sが含まれているが、その硫黄が触媒表面あるいはマイクロポアに $\text{SO}_x$ （硫黄酸化物）として付着（吸収）すると、触媒の浄化効率を低下させる。特に、上記した $\text{NO}_x$ 吸収触媒（ $\text{NO}_x$ 吸収剤）、即ち、リーン雰囲気で $\text{NO}_x$ を吸収し、未燃焼HC（還元剤）の供給を受けて吸収した $\text{NO}_x$ を還元浄化する触媒にあっては、硫黄が吸収されやすく、いわゆる硫黄被毒を生じて $\text{NO}_x$ 吸収効率を低下させている。

【0004】そこで、特開平6-66129号公報は、車両走行距離、 $\text{NO}_x$ 吸収量あるいは排気温度から硫黄被毒量を推定し、推定値が所定値を超えたとき、電気ヒータを一定時間通電加熱すると共に、供給する混合気の空燃比を理論空燃比にし、 $\text{SO}_x$ を除去して触媒を再生する技術を提案している。

【0005】また、特開平7-217474号公報も、機関回転数などから硫黄被毒量を推定し、推定値が許容値を超えると共に、排気ガス温度が所定値を超えると、供給する混合気の空燃比をリッチ化し、 $\text{SO}_x$ を除去して触媒を再生する技術を提案している。

## 【0006】

【発明が解決しようとする課題】ところで、日本国内で

販売される燃料中の硫黄は30ppmに規制されているが、米国では平均値で400ppm、規制値で1000ppmと硫黄含有量が多く、欧州でも国により異なるものの、数百ppm以上の国が過半数である。

【0007】燃料中の硫黄含有量が増加するにつれて硫黄被毒も増加することから、硫黄被毒を精度良く求めて触媒（ $\text{NO}_x$ 吸収剤）を的確に再生させる必要があるが、上記した従来技術においては車両走行距離などから硫黄被毒量を推定するものであって、排気ガス中の硫黄濃度を検出し、それに基づいて硫黄被毒量を推定して触媒再生処理を行うものでなかった。

【0008】従って、この発明の目的は上記した不都合を解消することにより、排気ガス中の硫黄濃度を検出し、それに基づいて硫黄被毒による $\text{NO}_x$ 吸収剤の劣化をより直接的に判定して的確に再生処理を行うようにした内燃機関の排気浄化装置を提供することにある。

## 【0009】

【課題を解決するための手段】上記の目的を達成するために、請求項1項にあっては、内燃機関の排気系に設けられ、排気ガスがリーン雰囲気にあるとき排気ガス中の $\text{NO}_x$ を吸収する $\text{NO}_x$ 吸収剤と、前記 $\text{NO}_x$ 吸収剤を加熱する加熱手段と、前記 $\text{NO}_x$ 吸収剤の配置位置の上流側に設けられ、排気ガス中の硫黄濃度を検出する硫黄濃度検出手段と、前記硫黄濃度検出手段の出力に基づいて前記 $\text{NO}_x$ 吸収剤の硫黄被毒による劣化を判定する劣化判定手段と、前記 $\text{NO}_x$ 吸収剤の温度を推定する温度推定手段と、前記劣化判定手段により前記劣化が判定され、かつ前記温度推定手段により推定された温度が硫黄被毒再生温度より高いとき、理論空燃比あるいはそれ以下のリッチ空燃比を供給する硫黄除去制御手段とを備える如く構成した。

【0010】これによって、排気ガス中の硫黄濃度を検出し、それに基づいて硫黄被毒による劣化をより直接的に判定することで劣化判定精度を向上させることができる。従って、硫黄含有量が多い燃料を用いるときも、 $\text{NO}_x$ 吸収剤の再生処理を的確に行うことができる。

## 【0011】

【発明の実施の形態】以下、添付図面に即してこの発明に係る内燃機関の排気浄化装置の実施の形態を説明する。

【0012】図1は、その排気浄化装置を概略的に示す全体図である。

【0013】図において、符号10は4気筒などの多気筒内燃機関（以下「エンジン」という）の本体を示し、吸気管12の先端に配置されたエアクリーナ（図示せず）から導入された吸気は、スロットルバルブ14でその流量を調節されつつサージタンクと吸気マニホールド（共に図示せず）を経て、各気筒へ流入される。

【0014】各気筒の吸気バルブ（図示せず）の付近にはインジェクタ（燃料噴射弁）16が設けられて燃料を

噴射する。噴射されて吸気と一体となった混合気は、各気筒内で図示しない点火プラグで点火されて燃焼してピストン（図示せず）を駆動する。

【0015】燃焼後の排気ガスは、排気バルブ（図示せず）および排気マニホールド（図示せず）を介して排気管18に送られる。排気管18においては上流側に三元触媒22が配置されて排気ガス中のHC、CO、NO<sub>x</sub>成分などを浄化すると共に、その下流にNO<sub>x</sub>吸収触媒（前記したNO<sub>x</sub>吸収剤）24が配置される。

【0016】NO<sub>x</sub>吸収触媒24は、先に述べた特開平6-66129号公報あるいは特開平7-217474号公報に記載されるNO<sub>x</sub>吸収剤と同種の触媒であって、リーン雰囲気（酸化雰囲気）で排気ガス中のNO<sub>x</sub>を吸収すると共に、排気ガス中の酸素濃度が低下すると、即ち、リッチ雰囲気において未燃HC、COと反応してNO<sub>x</sub>を還元浄化する。

【0017】ここで、NO<sub>x</sub>吸収触媒24を担持する担体は、素材を押し出し成形した後、焼成してセラミック化し、次いで適宜な長さに裁断して製作される。担体には電流路が形成され、NO<sub>x</sub>吸収触媒24自体が電熱ヒータ構造を備える電気加熱式の触媒として構成される。電流路は正負極端子24a、24bに接続される。

【0018】図1の装置は切換スイッチ26を備え、切換スイッチ26の端子26aが26bに切り換えられると、正極端子24aはオルタネータ28に接続され、オルタネータ28より電流の供給を受けてNO<sub>x</sub>吸収触媒24の温度を上昇させる。

【0019】尚、切換スイッチ26の端子26aが端子26cに切り換えられると、オルタネータ28の出力はバッテリー30の正電極に接続され、バッテリー30を充電する。バッテリー30の正電極は線32を介して前記した空気ポンプ34のモータ（図示せず）を含む電気負荷に接続される。

【0020】空気ポンプ34は、排気管18のNO<sub>x</sub>吸収触媒24配置位置の上流で分岐された分岐路36の他端に接続され、酸素を供給して未燃焼成分の燃焼を促進し、浄化効率を向上させる。

【0021】図1においてエンジン本体10のカム軸またはクランク軸（共に図示せず）の付近にクランク角センサ38が設けられ、所定クランク角度ごとに信号CRKを出力すると共に、特定気筒の特定クランク角度で気筒判別信号を出力する。

【0022】スロットルバルブ14にはスロットル開度センサ40が設けられてスロットル開度 $\theta_{TH}$ に比例した信号を出力する。その下流の分岐路42の末端には絶対圧センサ44が設けられ、吸気管内絶対圧PBAに応じた信号を出力する。

【0023】さらに、分岐位置の下流には吸気温度センサ46が設けられて吸入空気温度TAに比例する信号を出力すると共に、シリンダブロックなどの適宜位置には水

温センサ48が設けられてエンジン冷却水温TWに応じた信号を出力する。

【0024】さらに、排気管18にはO<sub>2</sub>センサ50が設けられ、排気ガス中の酸素濃度に比例した信号を出力する。

【0025】さらに、三元触媒22とNO<sub>x</sub>吸収触媒24の間には排気温度センサ52が設けられ、NO<sub>x</sub>吸収触媒24の配置位置付近の排気ガス温度Tcatに応じた信号を出力する。

【0026】さらに、NO<sub>x</sub>吸収触媒24の下流にはSO<sub>x</sub>センサ（前記した硫黄濃度検出手段）54が設けられ、排気ガス中の硫黄の濃度Scに比例する信号を出力する。

【0027】図2はSO<sub>x</sub>センサ54の構成を詳細に示す、説明断面図である。

【0028】SO<sub>x</sub>センサ54はジルコニア磁器などの酸素イオン伝導性の固体電解質層を積層してなる板状体を呈し、第1の測定室（内部空間）54a、第2の測定室（内部空間）54bおよび第3の測定室（内部空間）54cが形成されると共に、大気に連通する基準室54dが形成される。

【0029】排気ガスはガス拡散律速層54mを通して第1の測定室54aに流れる。第1の測定室54aには電極54e、54fでポンプセルが構成され、測定室内の酸素を汲み出し、酸素分圧をNO<sub>x</sub>が還元され得ない値に制御する。その酸素分圧を電極54g、54hの電位差として検出することで、排気ガス中の酸素濃度を検出する。

【0030】同様に、第2の測定室54bにはRhなどのNO<sub>x</sub>還元触媒からなる電極54i、54jが設けられ、電位差を検出することで酸素分圧、即ち、NO<sub>x</sub>の還元あるいは分解によって発生される酸素分圧を検出してNO<sub>x</sub>濃度を検出する。

【0031】同様に、第3の測定室54cにはPtなどのSO<sub>x</sub>還元触媒からなる電極54k、54lが設けられ、それらの電位差からSO<sub>x</sub>濃度を検出する。このように、SO<sub>x</sub>センサ54は、SO<sub>x</sub>濃度のみならず、酸素濃度とNO<sub>x</sub>濃度も併せて検出することができる。

【0032】これらセンサ群の出力は、電子制御ユニット（以下「ECU」と言う）60に送られる。

【0033】ECU60は、入力回路60a、CPU60b、記憶手段60c、および出力回路60dよりなる。入力回路60aは、各種センサからの入力信号波形を整形する、信号レベルを所定レベルに変換する、アナログ信号値をデジタル信号値に変換する、などの処理を行う。記憶手段60cは、CPU60bが実行する各種演算プログラムおよび演算結果などを記憶する。

【0034】CPU60bは前記したCRK信号をカウントしてエンジン回転数NEを検出し、検出したエンジン回転数NEと吸気管内絶対圧PBAとから燃料噴射量

(インジェクタ開弁時間)を演算し、目標空燃比などで補正する。

【0035】目標空燃比は、低負荷運転時には理論空燃比を超えるリーン方向の値(例えば30:1など)に、高負荷運転時には理論空燃比未満のリッチ方向の値(例えば12:1)に設定される。

【0036】さらに、CPU60bは、NO<sub>x</sub>吸収触媒24の硫黄被毒による劣化を判定し、その除去(再生)作業を行う。即ち、排気ガス中の硫黄成分がSO<sub>x</sub>(硫黄酸化物)として触媒表面あるいはマイクロポアに付着し、触媒の浄化効率を低下させる、いわゆる硫黄被毒が甚だしくなるとNO<sub>x</sub>吸収効率を低下させることから、吸収したSO<sub>x</sub>を除去してNO<sub>x</sub>吸収触媒24を再生させる。

【0037】次いで、この発明に係る内燃機関の排気浄化装置の動作を説明する。

【0038】図3は、その動作を示すフロー・チャートである。尚、図示のプログラムは、適宜な時間間隔(例えば80msec)ごとに実行される。

【0039】以下説明すると、S100において制御条件、より詳しくは硫黄被毒劣化判定および触媒再生処理を行う条件が成立しているか否か判断する。具体的には、NO<sub>x</sub>吸収触媒24が例えば300℃から400℃にあって活性化していると共に、エンジン10が定常運転状態にあるとき、この条件が成立と判断される。

【0040】S100で否定されるときは以降の処理をスキップすると共に、肯定されるときはS102に進み、前記したSO<sub>x</sub>センサ54の出力Sc(排気ガス中の硫黄濃度)をサンプリングする。

【0041】次いでS104に進み、検出した硫黄濃度Scおよび係数aに基づいてNO<sub>x</sub>吸収触媒24に吸収(吸着)されたと推定されるSO<sub>x</sub>積算量(即ち、硫黄被毒量)Stを算出する。

【0042】より具体的には、SO<sub>x</sub>積算量Stは、排気管18を流れた排気ガスボリュームVgを求め、求めた値に検出した硫黄濃度を乗じ、その積を前記した所定時間にわたって積算することで求める。

【0043】この排気ガスボリュームVgは、エンジン回転数NEと吸気管内絶対圧PBAとから検索自在にマップ化しておく。尚、係数aはNO<sub>x</sub>吸収触媒24の配置位置に供給されたSO<sub>x</sub>積算値の中の、NO<sub>x</sub>吸収触媒24に吸収(吸着)されたと推定される割合を示す係数である。

【0044】次いでS106に進み、求めたSO<sub>x</sub>積算量Stが所定値Aを超えるか否か判断する。ここで、所定値AはNO<sub>x</sub>吸収触媒24の劣化を判定するに足るしきい値であり、実験を通じて適宜な値を求めて設定する。

【0045】S106で否定されるときはNO<sub>x</sub>吸収触媒24が劣化していないと判定して以降の処理をスキッ

ブすると共に、肯定されるときはNO<sub>x</sub>吸収触媒24が劣化したと判定してS108に進み、被毒除去作業に入ってNO<sub>x</sub>吸収触媒24を通電加熱する。

【0046】より具体的には、前記した切換スイッチ26を介してオルタネータ28(あるいはバッテリー30)をNO<sub>x</sub>吸収触媒24のヒータの端子24aに接続し、通電加熱してNO<sub>x</sub>吸収触媒24を昇温させる。即ち、吸収されたSO<sub>x</sub>は触媒温度が700℃前後に達すると脱離することから、加熱昇温させる。

【0047】次いでS110に進み、検出した排気温度Tcatが所定温度Bを超えるか否か判断する。所定温度Bは700℃程度に設定する。S110で否定されるときは以降の処理をスキップすると共に、肯定されるときはS112に進んで空燃比を所定時間(短時間)リッチ化する。

【0048】その結果、排気ガスはリッチ雰囲気となり、NO<sub>x</sub>吸収触媒24から放出されたSO<sub>x</sub>は未燃HC、COで還元される。このようにしてNO<sub>x</sub>吸収触媒24を再生することができる。

【0049】尚、検出しているのはNO<sub>x</sub>吸収触媒24の配置位置付近の排気温度であり、NO<sub>x</sub>吸収触媒24の温度そのものではないが、検出値を適宜補正することにより、触媒温度とみなすことができる。

【0050】この実施の形態は上記の如く、排気ガス中の硫黄濃度Scを検出し、それに基づいて硫黄被毒による触媒劣化をより直接的に判定し、劣化と判定されるときは再生処理を行うようにしたので、NO<sub>x</sub>吸収触媒の硫黄被毒による劣化を精度良く判定することができ、再生処理を行うことができる。従って、燃料の硫黄含有量が増加してもNO<sub>x</sub>吸収触媒24を的確に再生することができる。

【0051】図4はこの発明の第2の実施の形態に係る内燃機関の排気浄化装置の動作を示すフロー・チャートである。

【0052】第1あるいは第2の実施の形態と相違する点に焦点をおいて説明すると、S200からS208までの処理を行ってS210に進み、NO<sub>x</sub>吸収触媒24への通電時間TONが所定時間Cを超えたか否か判断する。

【0053】所定時間Cは、NO<sub>x</sub>吸収触媒24の温度が700℃に達したと判定するに足る値を適宜求めて設定する。

【0054】S210で否定されるときは以降の処理をスキップすると共に、肯定されるときはS212に進んで第1あるいは第2の実施の形態と同様に空燃比を短時間リッチ化する。

【0055】第2の実施の形態においては上記の如く、通電加熱してNO<sub>x</sub>吸収触媒24の昇温を促進するようにしたので、第1の実施の形態と同様に的確に被毒除去作業を行うことができる。

【0056】また、通電時間TONから排気温度（換言すれば触媒温度）Tcatを推定するようにしたので、排気温度センサ52の設置を省略することができる。尚、残余の構成および効果は第1の実施の形態と同様である。

【0057】図5はこの発明の第3の実施の形態に係る内燃機関の排気浄化装置の動作を示すフロー・チャートである。

【0058】従前の実施の形態と相違する点に焦点をおいて説明すると、S300からS308までの処理を行ってS310に進み、NOx吸収触媒24への通電電力量Eが所定電力量Dを超えたか否かを判断する。

【0059】通電電力量Eは電圧センサおよび電流センサ（共に図示せず）を適宜設置して印加電圧Vおよび印加電流Iを検出することで算出する。また、所定電力量Dは、NOx吸収触媒24の温度が700℃に達したと判定するに足りる値を適宜求めて設定する。

【0060】S310で否定されるときは以降の処理をスキップすると共に、肯定されるときはS312に進んで第1あるいは第2の実施の形態と同様に空燃比を短時間リッチ化する。

【0061】第3の実施の形態においても通電加熱してNOx吸収触媒24の昇温を促進するようにしたので、従前の実施の形態と同様に的確に被毒除去作業を行うことができる。尚、残余の構成は従前の実施の形態と同様である。

【0062】この発明の第1ないし第3の実施の形態は上記の如く、内燃機関（エンジン）の排気系（排気管18）に設けられ、排気ガスがリーン雰囲気にあるとき排気ガス中のNOxを吸収するNOx吸収剤（NOx吸収触媒24）と、前記NOx吸収剤を加熱する加熱手段（NOx吸収触媒ヒータ）と、前記NOx吸収剤の配置位置の上流側に設けられ、排気ガス中の硫黄濃度Scを検出する硫黄濃度検出手段（SOxセンサ54）と、前記硫黄濃度検出手段の出力に基づいて前記NOx吸収剤の硫黄被毒による劣化を判定する劣化判定手段（ECU60、S106、S206、S306）と、前記NOx吸収剤の温度Tcatを推定する温度推定手段（排気温度センサ52、ECU60、S110、S210、S310）と、前記劣化判定手段により前記劣化が判定され、かつ前記温度推定手段により推定された温度が硫黄

被毒再生温度（700℃）より高いとき、理論空燃比あるいはそれ以下のリッチ空燃比を供給する硫黄除去制御手段（ECU60、S110からS112、S210からS212、S310からS312）とを備える如く構成した。

【0063】尚、上記において、SOxセンサ54は、特開平6-174692号公報あるいは特開平9-189678号公報に記載される構造を備えるものであっても良い。また、SOxセンサ54は、排気ガス中の硫黄の濃度を検出するようにしたが、絶対量を検出するものであっても良い。

【0064】尚、上記において、上流側の触媒22を三元触媒としたが、NOx吸収触媒であっても良い。

【0065】

【発明の効果】請求項1項にあっては、排気ガス中の硫黄濃度を検出し、それに基づいて硫黄被毒による劣化をより直接的に判定することで劣化判定精度を向上させることができる。従って、硫黄含有量が多い燃料を用いるときも、NOx吸収剤の再生処理を的確に行うことができる。

【図面の簡単な説明】

【図1】この発明に係る内燃機関の排気浄化装置を含む内燃機関の制御装置を全体的に示す概略図である。

【図2】図1装置のSOxセンサの構成を詳細に示す説明断面図である。

【図3】この発明に係る内燃機関の排気浄化装置の動作を示すフロー・チャートである。

【図4】この発明の第2の実施の形態に係る内燃機関の排気浄化装置の動作を示すフロー・チャートである。

【図5】この発明の第3の実施の形態に係る内燃機関の排気浄化装置の動作を示すフロー・チャートである。

【符号の説明】

10 内燃機関（エンジン）本体

18 排気管（排気系）

22 三元触媒

24 電気加熱式NOx吸収触媒（NOx吸収剤）

38 クランク角センサ

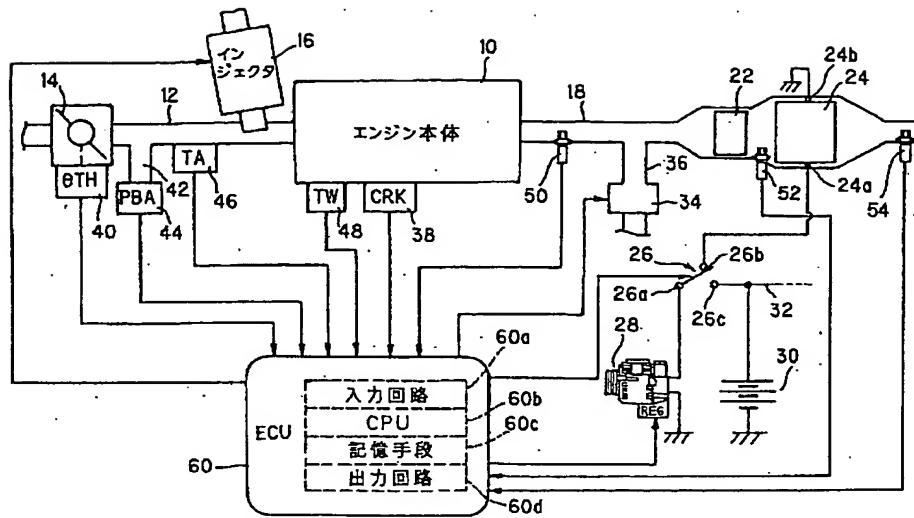
44 絶対圧センサ

52 排気温度センサ（温度検出手段）

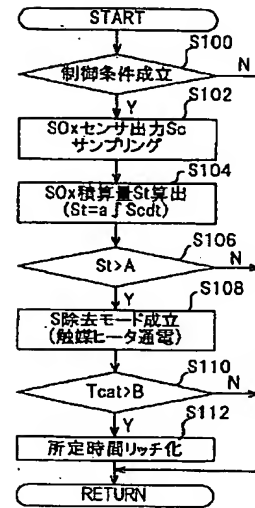
54 SOxセンサ（硫黄濃度検出手段）

60 ECU（電子制御ユニット）

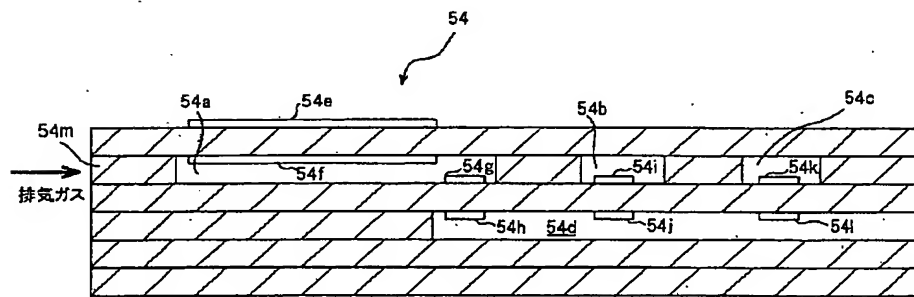
【図1】



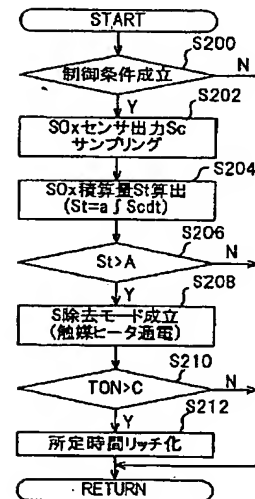
【図3】



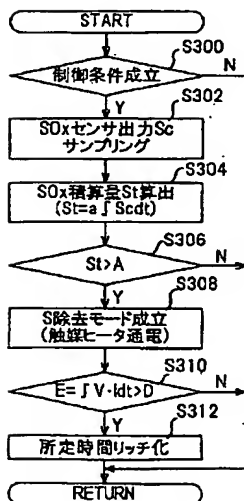
【図2】



【図4】



【図5】





## フロントページの続き

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